VIII. *Note on the habits and structure of* Acanthopsyche opacella, H.-Sch. By T. A. Chapman, M.D., F.Z.S.

[Read June 6th, 1900.]

Plate VIII.

Having found *Acanthopsyche opacella* this spring rather freely at Locarno, I took the opportunity of noting some items about it that have not hitherto been much examined. I may note, in the first place, that the species occurs everywhere at Locarno up to a height of at least 1500 feet above the lake, generally however very sparingly. It is most common in the lower cultivated grounds, especially amongst the vineyards, which consist here of long rows of vines, trained on maple or other trees, with wide spaces between the rows. These spaces are sometimes cultivated, sometimes left for some years in grass. I believe it is these grassed areas that suit *opacella*, as the cases may be found near them on tree trunks, and especially on the stone posts that flank the roadside, when the road passes through such an area. It appears to emerge chiefly in April, but earlier or later according to season, with some individuals much earlier and later, spreading the period of its emergence over at least two months.

On April 18 I happened to find a male *opacella* just emerged, at about 4 p.m. Emergence takes place between 1 and 5 p.m. On opening the box again a minute afterwards I found he had paired with a female that was in the same box. His attitude was much the same as that of *Standfussia tenella* and other Psyches when paired, one that is common I imagine to all the Psyches—viz. buried in the female sac so that its mouth presses against the bases of the hind wings, the thorax bent forwards and the wings slightly spread and very much deflexed so as to cover the mouth of the sac. He allowed me to raise his wings without being disturbed, and I could see the first two pairs of legs stretched downwards in front of the moth and sac; the hind pair I could not see. I killed the moth suddenly by applying a drop of chloroform. He never stirred or loosened a claw, so that he now remains

in the actual attitude that is normal in every respect except that the wings are raised to show the position of the body and legs. The condensation of the fur by the chloroform has made the position of the third pair of legs quite visible. It is not the case, as I suspected from an imperfect observation last year, that the third pair of legs enters the sac, at least not tarsi first, but they enter it trochanters first, and so far, that the edge of the mouth of the sac is in the angle behind the knee, if we may so call the femoro-tibial articulation. The tibiæ and tarsi are closely appressed to the outside of the sac, parallel with its long axis, and are so small and buried amongst the materials clothing the sac, that though quite visible are not at all evident till carefully looked for.

They could not be appressed to the case as they are if the tibiæ possessed spines as in the lower Psychids. I had afterwards some further opportunities of observing pairing in *A. opacella*. The means by which the male manages to insert the abdomen into the case of the female, and reach the further end of the interior of the pupa case have, I think, never been explained. In the female ovipositor, the extensile segments, whether used for piercing plant tissues as in the Eriocraniids and Adelids, or to reach a distant point for oviposition, as illustrated especially in the Talæporiads and Fumeids, are manipulated by a special arrangement of rods with intrinsic muscles. In some Talæporiads these rods are equal in length to the whole abdomen, and indeed when at rest these anterior extremities reach not only the thorax but the head of the insect. In these ♂ Psyches—my observations refer at present of course to *opacella*—there is no arrangement of this sort, no structure in fact that does not exist in the abdomen of almost any other Lepidopteron.

I saw several specimens pairing, and noted that the basal segments of the abdomen whilst still outside the case, were inflated with air, so that the limp intersegmental membrane being stretched gave quite a solid basis and connection of parts. A specimen suddenly killed, and examined at once by opening the female sac, was seen to have the segments intervening between the mouth of the sac and the pupal case inflated in this way. Those inside the pupa case and extending to its base, quite visible through the nearly transparent pupa shell, were not

inflated in the sense of being swollen and rotund, but appeared to be so, so far as pressure between the female and her pupal shell allowed.

The mechanism by which this inflation occurs I have never determined, but it is doubtless a special modification of that possessed by many insects and especially Lepidoptera, by which the abdomen is inflated at the period of emergence from the pupa.

The female of *A. opacella* in perfect condition is a very different creature from my previous idea of it, or what one can gather from any published descriptions I have seen except the notes by Dr. Max Standfuss.

As usually seen and described it is a naked white maggot, with some dark shining head and thoracic plates, some almost recognisable mouth parts and rudimentary true legs. Otherwise it is a mere egg bag. Barrett tells us it has "small tufts of erect soft white hairs at the sides of the seventh to ninth segments." The genuine animal has however a much more elaborate clothing than this, the difficulty is to obtain it with this still *in situ*.

My first note is as follows,—"a ♀ of *opacella* in good condition, I noticed that the wool with which she lines the mouth of the sac and partially disposes amongst the eggs, arises in five or six tufts placed on each side of certain abdominal segments. I meant to make closer observations later, but when I came to do so, she had rubbed the wool off, and I have not again succeeded in finding a ♀ with the wool perfect, she begins to rub it off in her first journey to open the mouth of the sac, and though keeping a sharp eye for sacs at this stage, I have so far always found the ♀ already denuded and the wool loose in the mouth of the sac and of the pupal shell."

The ♂ larva increases the length of the funnel at the open end of the sac, which serves to hold the pupa whilst he emerges, and which consists of little else than silk without any covering of chips of bark, wood, etc., but he makes no other addition to the sac. The ♀, on the other hand, may repair and trim up the mouth of the sac, but practically leaves it of its larval size and structure; but within this, she closes the mouth of the sac by spinning a quantity of silk as a loose network, so that it forms a sort of cocoon, in front of and in some extent fitting the anterior of the pupa, between it and the mouth of the sac. In *opacella* this spinning does not extend backward, but in

some exotic Œketicids with large roomy sacs, it extends all round the pupa, forming a loose hammock inside the sac, in which it rests. We are concerned however just now with *opacella*. This silk must have a somewhat valvular arrangement as the moth forces her way through it, to protrude the thoracic segments from the sac, and on retiring the silk largely closes together again. One such journey results in great damage to her growth of silky wool, which is entangled in the mouth of the pupa case, amongst this silk and in the open mouth of the sac.

It occurred to me that the only way to find a specimen with this clothing of wool complete would be to find a specimen still unemerged from the pupa, though thoroughly mature, and to carefully remove the pupa case.

This is not quite so easily done as said; I succeeded, however, in several instances, with very little damage to the specimens.

A specimen so obtained, presents six abdominal segments, with rings of white, silvery or silken hairs or wool, encircling them more or less completely except dorsally.

The first abdominal segment is a narrow one and has no clothing. The next six segments, second, third, fourth, fifth, sixth and seventh, have each a ring of wool clothing the whole segment, with the exception of a narrow break dorsally. The wool arises from the whole segment, as we usually understand a segment, but each ring of wool is separated from the next by the naked area formed by the expanded intersegmental membranes. The hairs are a little denser on each side of the ventral line, again above this, and again beneath the spiracles, but hardly enough so to entitle these to be called tufts. The hairs are waved, and though not perfectly white, have a very white silvery silken look against the yellower tint of the insect itself.

The interior silken net of female sac, when it becomes a cocoon, has several uses. The female pupa does not leave the sac; but more than this it has to be kept in its place during the several journeys to and fro that the moth makes from it to the mouth of the sac and back, and also during the access of the male. In *A. opacella* it accomplishes this by fitting the front of the pupa case, and also by some of its meshes being caught and entangled on the projections that the appendages, aborted mouth parts, legs, etc. present. It thus acts as a cremaster both before and after the emergence of the moth, preventing the

pupal case being shoved back on the retreat of the moth into it.

The larval sac is a tube along which the larva and male pupa can travel to and fro with facility, so could the female pupa were it not fixed in this way and by the exserted intersegmental dorsal spines. But the female moth is in a different position, the tube along which it has to travel is not the larval sac posteriorly, but the empty pupa case; anteriorly the larval sac does not correspond with this, but is of course considerably larger just at the anterior end of the pupa. The silken mesh or hammock (partial) we are considering, just bridges over this space, and so proves a guide to the female in her retreat to the pupa case, preventing her from missing the opening, which otherwise she would be tolerably certain to do, as well as preventing her pushing it back behind her instead of entering it. It would be still more impossible for the male moth to find this opening, even assuming, as is probable, that he keeps more or less in touch with the female whilst she retires; that he does not always so keep in touch is also however probable, as pairing takes place, even when the female is not at the opening of the sac on the arrival of the male.

This silk mesh must have a definite valvular structure, admitting of the moths finding an easy tubular road through it, and yet closing up when they are not using it. It must therefore of itself present some valuable protection against the entry of enemies, against which the moth first, and afterwards for some weeks her eggs, require protection. It is probably largely in aid of this function that the structure is so effectual in rubbing off the woollen clothing of the moth. So effectual is it that in a very short time, a moth having made a few journeys through it to and fro, becomes quite denuded and presents the usual appearance of a bare maggot. The great mass of the hair remains in this position, that which escapes from the mouth of the sac and that that gets distributed amongst the eggs, being trivial in amount and apparently accidental.

In some large exotic species a large mass of these hairs occurs at this position, and even in *A. opacella* the amount is very considerable, much greater when teased up than it appeared when dispersed in orderly fashion on the moth. On first opening a female case containing eggs it is rather difficult to distinguish this hair from the silken net that

holds it; one appreciates what an admirable protection it must afford against small marauders of all sorts, but wonders a little how the moth herself passed so easily through it to and fro, and yet left the wool so admirably disposed as it is, since her last act is to leave the sac, by passing through this obstacle.

The female moth does not always drop out of her sac if unfertilised, but often dies within it. But if all goes well she always does so, as soon as she has laid all her eggs. If found immediately, one is surprised to observe that she has diminished in bulk to a very trifling degree. It is easy to see that the bulk is obtained by the inflation of the abdominal cavity with air. The use of this arrangement, as in some of the lower Psychids which have a precisely similar habit, one may safely conclude to be to prevent collapse to a state of absolute flaccidity, when muscular action would be impossible owing to the approximation of all the parts rendering further movement impossible, yet muscular action is absolutely necessary to complete the egg-laying and the emergence of the effete moth from the sac. The falling out of the moth is probably a provision to admit of the elastic silk structure in the throat of the sac to close, a closure completed by the wool off the moth entangled with it, making it impervious to any enemy unacquainted with its valvular arrangement.

If the moth died amongst the silk she would not only hold it open but herself form an edible highway to various enemies.

In special connection with the Psychids, some questions as to homologies of the neuration in various Lepidoptera have forced themselves on my attention, and I was glad to be able to examine some specimens of *A. opaccila*, to get a little light on the matter.

There are in Lepidoptera four internal veins in the fore wings of all pupæ I have so far examined. Of these the first is not truly an internal vein, but is a branch of the cubitus. It has however been for so long called an internal vein (1c of Meyrick and Hampson, 1st anal of Comstock) that I fear it must continue to be so named, it is however given off at the base of the cubitus (the main vein giving rise to 2 and 3 of Meyrick and Hampson).

The three other internal veins arise by a common stem quite separately from the cubitus. The first of these (1b of Meyrick, 2nd anal of Comstock) is the one that is so

persistent, and always reaches the margin of the wing. The third or inner one, though very constant and well within the wing area at an early stage, soon becomes quite a marginal vein, and does not so far as I know leave any trace in the imaginal wing. The second or intermediate one (1a of Meyrick and Hampson, 3rd anal of Comstock) may or may not persist in the imago, it usually joins the first near the base, and there are very few exceptions (if any) to the rule that it never reaches the margin of the wing. In *Psyche* this vein joins the 2nd anal (1b) in the manner that is so very usual, but further on appears to leave it again and proceed to the inner margin, forming one of the exceptions I have alluded to where this vein does not follow the rule of failing to reach the margin.

In the case of *A. opacella*, I have succeeded in examining the pupal wing at a suitable late stage, when the relationship of the primary pupal tracheæ to the imaginal veins is obvious. In these examples the trachea of the 3rd anal (1a) is short and occupies the position of the lower loop of the bifurcation, without quite reaching the 2nd anal (1c). At about this point the 2nd anal trachea divides into two stems which keep together for a short distance and then one goes on in the normal course of that vein, the other proceeds more directly to the inner margin, forming the inner vein so characteristic of the Psychids. The important point is that this vein is not a continuation of the 3rd anal (1a) after coalescing for a time with the 2nd (1b), but is a new development of that vein. It clears away this one apparent exception to the rule that the 3rd anal never reaches the wing margin. In the Œketicids there are several veins in this position, two, three, or even more, though it is clear these could not all be a simple continuation of the 3rd anal (1a); this observation on *A. opacella* renders it tolerably certain that they are all fresh developments of the 2nd anal. A small tracheal twig from the 2nd anal marks the place of anastomosis with the 1st anal (1c).

As regards the hindwings *A. opacella* presents nothing having a very wide significance. But its special place in the scheme of evolution of the anterior veins of the hindwing are possibly important. My few observations on these appear to suggest that the primary frenate subcosta (8 of Meyrick and Hampson) was formed by the union of the true subcostal vein, with the first branch of the radius

R_1, and that these two tracheæ passed together to the termen of the wing and formed the basis of vein 8 (Meyrick). Since vein R_1 originated at some distance from the base of the wing, the position where the two veins joined was marked by a transverse vein, the bar between 8 and the cell present in many families.

The further progress of this condition took two directions, or rather had two elements. The first was a tendency of the bar to travel to the base of the wing. The extreme of this condition is found in Papilionids, Vanessids and Pierids, possibly in all butterflies, but I have not yet examined skippers or Lycœnids, in which vein 8 possesses both tracheæ from the base of the wing to the termen.

The other change was for one or other trachea to atrophy beyond the bar. In *Sphinx* R_1 disappeared until only sufficient remains to form the bar.

In *Polyplocidæ* both changes took place, vein 8 is entirely R_1, originating close to the wing base, and the subcostal is only a minute trachea almost lost in the wing base.

In *A. opacella* the condition present is an atrophy of the subcostal beyond the bar, the vein 8 up to the bar is subcostal, beyond it R_1. In this respect it agrees with the few Caradrinids I have examined.

Plate VIII.

[*See explanation facing the* Plate.]